

Impact of neuromonitoring of recurrent laryngeal nerve and surgical loupes on the outcome of thyroidectomy

A retrospective chart review

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ABSTRACT

الأهداف: تحديد ما إذا كان استخدام العدسة الجراحية لتحديد الغدة الجار درقية والعصب الحنجري الراجع مع الرصد العصبي لوظيفة العصب الحنجري الراجع خلال عملية استئصال الغدة الدرقية يقلل نسبة المضاعفات اللاحقة للعمليات الجراحية.

الطريقة: أجريت دراسة رجعية لجميع العمليات الجراحية الأولية لاستئصال الغدة الدرقية والتي أجريت في مستشفى الملك عبدالعزيز الجامعي، الرياض، المملكة العربية السعودية خلال الفترة من يوليو 2007م حتى سبتمبر 2011م على اشتراط أن تكون أعمار المرضى أكثر من ستة عشر عاماً، وأن لا يكونوا قد خضعوا لعمليات سابقة في الرقبة وأن لا يكونوا مصابين مسبقاً بنقص الكالسيوم أو بأي نوع من أنواع شلل الحبال الصوتية. تم تحليل نتائج الدراسة بالتركيز على المخرجات والتي تتضمن معدل المضاعفات اللاحقة للعملية، واستخدام أنبوب النزح ومدّة الإقامة في المستشفى بعد العملية.

النتائج: خضع 88 مريضاً لعملية في الغدة الدرقية خلال فترة دراستنا. استؤصلت الغدة الدرقية بشكل كلي لدى 61 مريضاً. تعرض بعد العملية 15.9% من المرضى لنقص مؤقت للكالسيوم و5.7% لنقص دائم ولم يصاب أي مريض بشلل الحبال الصوتية أو التهابات الجرح أو أزمة الغدة الدرقية. تراوحت فترة الإقامة في المستشفى بين يومين إلى سبعة أيام.

خاتمة: أن الرصد العصبي الدقيق لوظيفة العصب الحنجري الراجع أثناء العملية مع استخدام العدسات الجراحية سيقلل من المضاعفات اللاحقة للجراحة ومدّة الإقامة في المستشفى بعد العملية و يحسن من نوعية الرعاية المقدمة للمرضى.

Objectives: To determine whether the post-operative complication rate of thyroidectomy can be reduced using surgical loupes to identify parathyroid gland and recurrent laryngeal nerve (RLN) with simultaneous intraoperative neuromonitoring of RLN.

Methods: This retrospective chart review was conducted from December 2012 to March 2013 at the Ear, Nose, Throat, and Head-Neck Department of King Saud Hospital, Riyadh, Kingdom of Saudi Arabia. The study group included patients who underwent primary thyroid surgeries performed from July 2007 to September 2011, older than 16 years old, without history of vocal cord palsy, hypocalcemia, and sternotomy. Patient outcomes were analyzed with emphasis on complication rates related to the procedure, operative duration, use of drain, and length of hospital stay.

Results: Eighty-eight patients underwent thyroid surgeries during our study period. Sixty-one underwent total thyroidectomy. Temporary hypocalcemia accounted for 14 (15.9%), and permanent hypocalcemia accounted for 5 (5.7%) of the patients. None of the patients showed vocal cord paralysis, wound infections, or thyroid crisis post-operatively. The length of hospital stay was 2-7 days.

Conclusions: Careful neuromonitoring of the RLN nerve using surgical loupes will minimize post-surgical complications, decrease hospital stay, and eventually improve surgery outcomes.

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Thyroid surgery was considered a fatal surgery with 40% mortality rate in the middle of the nineteenth century.¹ At that time, majority of the mortality resulted from sepsis or hemorrhage.¹ Nowadays, mortality is rare, but post-operative complication still fluctuates from surgeon to surgeon, depending on several factors, such as surgical skills and experience.² One of the most common and serious complication in post-thyroidectomy is permanent or temporary hypocalcemia. This condition arises usually secondary to sudden unintentional removal, or devascularization of parathyroid gland. Inferior parathyroid glands are at risk of inadvertent removal or vascular damage during clearance of para-tracheal and pre-tracheal nodes in the central neck.³ A study conducted on 806 patients in India showed an overall incidence of hypocalcemia (23.6% [n=190]), and permanent hypocalcemia (1.61% [n=13]).⁴ In another study conducted in Spain, transient hypocalcemia was present in 29.1% of the patients, and permanent hypocalcemia was present in 4.7%.⁵ Iatrogenic injury to recurrent laryngeal nerve (RLN) is another serious and common complication in post-thyroidectomy patients. The risk is increased if the nerve is not identified during operation, if the patient has thyroid cancer, or has previous thyroid operation.⁶ The average incidence of temporary (9.8%), and permanent RLN (2.3%) paralysis was also reported.⁷ Some studies suggest that neuromonitoring does not contribute in decreasing the risk of RLN injury,⁸ whereas other studies have proven routine identification of RLN in addition to modern techniques, such as neuromonitoring of the nerve decreases the rate of RLN palsy.⁹ Moreover, using surgical loupes during the operation provides the surgeon a good view and magnification of the RLN and parathyroid glands, thus, reduces its complications.^{10,11} This study was conducted to determine whether using surgical loupes to identify parathyroid gland and RLN along with simultaneous intraoperative neuromonitoring of RLN reduces post-operative complication rates.

Methods. This retrospective chart review of all primary thyroid surgeries performed by and under the supervision of one Ear, Nose, Throat, and Head-Neck (ENT-HN) consultant at the ENT-HN Department of King Saud Hospital, Riyadh, Kingdom of Saudi Arabia was conducted between July 2007 to September 2011.

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The inclusion criteria were: age older than 16 years old; not diagnosed with vocal cord palsy pre-operatively; did not need sternotomy; and with no history of prior thyroid surgery. Any patient who was previously detected to have hypocalcemia by laboratory investigations, or was receiving calcium supplementation with or without additional vitamin D supplementation was also excluded from the study. Only 3 patients who were diagnosed and operated by the same surgeon later had to undergo completion surgery, and were included in this study. All the operations were performed by one particular head and neck surgeon who used the same surgical technique (outlined below). This research was approved by the institutional review board of the College of Medicine, King Saud University, Riyadh, Saudi Arabia and was carried out in agreement with the Declaration of Helsinki.

Literature review. Original articles, peer-reviewed clinical trials and review articles were identified from the databases MEDLINE using search terms “thyroidectomy”, “hypocalcemia”, “recurrent laryngeal nerve neuromonitoring”, and “surgical loupes”.

Surgical technique. A 6 cm midline transcervical incision was placed 3 cm above the suprasternal notch. Strap muscles of the neck were splitted in the midline. Ligation and division of all the vessels were performed by Unipolar diathermy, bipolar diathermy and non-absorbable clips. Magnification by surgical loupes assisted in the identification of parathyroid glands. The RLN were identified (Figure 1) using a nerve stimulator. The nerve was stimulated near the strap muscle and the laryngeal twitch was assessed by the index finger. Every patient was assessed pre-operatively by video nasolaryngoscopy and assessed post-operatively for clinically detectable hoarseness. Serum calcium level was measured pre-operatively, and 6, 12, and 20 hours post-operatively. In those patients who continued to demonstrate lower than normal serum calcium level, we had the level calculated twice every day until the day of discharge. Patients who had post-operative biochemical calcium level below 2.1 mmol/L in any of the blood samples were labeled as patients with temporary hypocalcemia. If the calcium level remained persistently lower than 2.1 mmol/L for 3 months or more, or the patient required calcium supplementation for more than 3 months post-surgically, they were labeled as permanent hypocalcemic. These patients were referred to the Endocrinologists for further assessment, management, and follow-ups regarding their hypocalcemic state. We analyzed patient outcomes with emphasis on length of hospital stay, operative duration, use of drain, and complications related to the procedures.

Statistical analysis was carried out using the Predictive Analytics Software (PASW) version 18 (IBM-SPSS, Chicago, IL, USA). Associations between different variables were tested using the student t-test and Chi-square test. A $p < 0.05$ was considered statistically significant.

Results. Eighty-eight patients underwent thyroid surgeries during our study period. Eighty-one patients were women (92%) and 7 (8%) were men. The mean age of women was 38.8 years, and 33.5 years for men. The series included 61 (69.3%) total thyroidectomies and 27 (30.7%) other types of thyroidectomy including hemithyroidectomy and 3 completion thyroidectomy. The mean duration of surgery was 141 minutes for hemithyroidectomy, and

184 minutes for total thyroidectomy. Fifty-two (59%) of these procedures were performed for benign diseases, including multinodular goiter (MNG), follicular adenoma, Hurthle cell adenoma, Graves' disease, and Hashimoto thyroiditis (**Figure 2**). Cancer accounted for 36 (41%) of the procedures, and included papillary thyroid cancer (PTC) and follicular cancer (**Figure 2**). Insertion of surgical drain was required for only 23 patients (26.1%) for one to 3 days, and 16 of them had total thyroidectomy. The hospitalization period for our patients ranged from 2-7 days, with an average of 4 days. Post-operative complications are shown on **Table 1**. Both temporary and permanent hypocalcemia developed only in patients who underwent total thyroidectomy. Even the completion thyroidectomy patients did not have any episode of temporary or permanent hypocalcemia. None of the patients presented with hoarseness of voice post-operatively. There was no incidence of wound infections or thyroid crisis in the post-operative period.

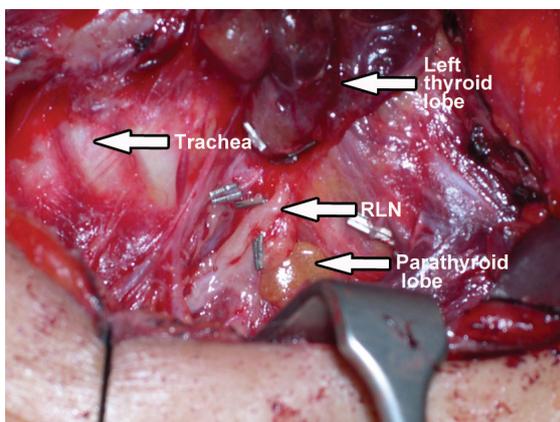


Figure 1 - Intraoperative identification of recurrent laryngeal nerve (RLN) and parathyroid gland.

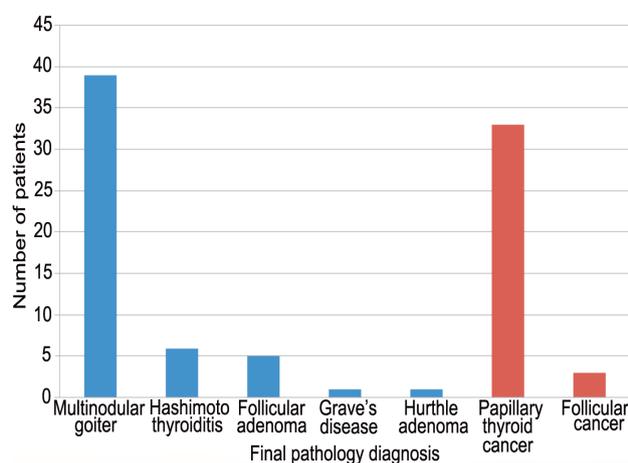


Figure 2 - Final pathology of thyroid patients operated at the Ear, Nose, Throat, and Head-Neck Department of King Saud Hospital, Riyadh, Kingdom of Saudi Arabia.

Discussion. Our results shows lower incidence of temporary hypocalcemia compared to the findings stated in the literature,^{4,5} and there was no incidence of vocal cord paralysis. Our study showed a preponderance of the thyroid diseases to the female gender (mostly MNG). Most of the total thyroidectomies performed showed benign results in the histopathological report ($p < 0.002$). In the literature,^{12,13} there were some similarities and differences regarding the aforementioned variables, that is, in a big cohort study of 15 years duration involving 1500 thyroidectomies, 1113 (74.2%) presented with benign thyroid disease, mostly MNG. In their cohort, total lobectomy was the procedure of choice.¹² The British Association of Endocrine and Thyroid Surgeons Third National Audit Report 2009¹³ informed that 19.6% of the patients with thyroid mass have a malignant lesion with PTC being the most common one. Most of the cases were females, but cancer was more prevalent among males, and lobectomy was carried out more than total thyroidectomy.¹³

The use of unipolar and bipolar electrocautery for vessel ligation in addition to the non-absorbable clips has decreased hematoma incidence in our study, that might have played a part in minimizing the use of drain. In a study by Tysome et al,¹⁴ bipolar diathermy use for vessel ligation showed less drain use, and less hospital stay than in the clamp and tie technique. But none of the techniques demonstrate significant difference in the rate of complications considering post-operative bleeding, hypocalcemia, and vocal cord palsy.¹⁴ Routine drain insertion after uncomplicated thyroidectomy is not

Table 1 - Complication rates among 88 patients who underwent thyroid surgeries at King Saud Hospital, Riyadh, Kingdom of Saudi Arabia from 2007-2011.

Complications	n	(%)
Hypocalcemia, temporary	14	(15.9)
Hypocalcemia, permanent	5	(5.7)
Hematoma	1	(1.1)
Vocal cord paralysis	Nil	
Wound infection	Nil	
Thyroid crisis	Nil	

encouraged anymore because it may increase the hospital stay and augment patient discomfort ($p < 0.0001$). Furthermore, the practice of routine use of drainage was not proven to be more beneficial in preventing or decreasing post-operative complications.¹⁵⁻¹⁷ The incidence of RLN injury in our study was nil, which is lower than what was previously reported in the literature.^{12,13,18} For instance, the incidence of vocal cord paralysis (VCP) in the Watkinson cohort study¹² was 2.4% for temporary VCP, and 0.4% for permanent VCP. Furthermore, another study¹³ showed a 2.5% incidence of VCP, whereas 6% of patients complained of transient VCP, and 0.6% had permanent VCP in another cohort.¹⁸ The lower incidence of RLN injury in our study might be related to using surgical loupes to identify RLN properly. It is suggested by some studies¹⁰ that loupe magnification aids in preventing the RLN injury. Likewise, the use of nerve stimulator intraoperatively might be another factor that facilitated the identification. On the contrary, some studies stressed that there is no significant advantage in using the nerve stimulator to avoid RLN injury, except to decrease the RLN identification time, and consequently the operation time.^{9,19} Some other investigators emphasized on the use of intraoperative neuromonitoring especially when the dissection is approached bilaterally.²⁰ In addition to mere identification, a review by International Neural Monitoring Study Group published in 2011 advocated the application of Intraoperative Neural Monitoring (IONM) to trace the nerve and its branches throughout the dissected field, assess the post-operative neural function and determine the lesion site.²¹ It is undeniable that following this guideline will improve surgical outcomes and reduce the complications of thyroidectomy.

All our patients were assessed clinically 2 weeks post-operatively for RLN injury, and none of them demonstrated symptoms of RLN nerve dysfunction.

Different methods in the literature were used by different surgeons to monitor the RLN function before, and after the operation. A systematic review of 27 articles involving 25000 patients underwent thyroidectomies and resulted in different rates, both transient and persistent RLN palsy, depending on which method was used to monitor the RLN post-operatively. This method included indirect laryngoscopy (mirror), fiber optic nasolaryngoscopy (direct), and video stroboscopy. The overall rate of transient RLN palsy post-thyroidectomy ranged between 1.4-38.4% with an average of 9.8%. The overall rate for permanent RLN palsy post-operatively was 0-18.6%, with an average of 2.3%. The highest rate was observed with indirect laryngoscopy, and lowest with stroboscopy. Direct (video nasolaryngoscopy) is the gold standard in terms of specificity, sensitivity, availability, and cost effectiveness.⁷

The incidence of hypocalcemia (15.9% transient and 5.7% permanent) in our study is different than the rates reported in the previous studies.^{4,5,18,22} Our rates of transient hypocalcemia are lower than previous reports, while our rates of permanent hypocalcemia are higher than those reported in the literature.^{4,5,18,22} Transient type was associated with differentiated thyroid carcinomas and thyrotoxicosis.¹² Central neck dissection resulted into transient (18-51%) and permanent hypocalcemia (1-12%).²² In patients with well-differentiated thyroid carcinoma without post-operative drains, 23% had transient hypocalcemia, and 1% had permanent hypocalcemia.¹⁸ The reason behind having high rates of permanent hypocalcemia in our study might be due to the criteria used in our study to define permanent hypocalcemia. Our criteria were persistently low calcium level more than 3 months requiring calcium or Vitamin D supplement. Whereas other studies' definition of permanent hypocalcemia is persistent supplementation more than 6 months,¹² more than one year,¹⁸ or more than 2 years.²² The cut-off point of 3 months might have contributed to the higher number of patient who was accommodated in the group of permanent hypothyroidism. Central compartment neck dissection can cause an increase in the rate of both types of hypocalcemia as mentioned previously, however our study did not have the number of those who underwent central neck dissection intraoperatively, which can be considered as a factor affecting the rate of hypocalcemia. Surgical site infection post-operatively is more in the literature^{12,23-25} than what was revealed in our study. The same as in site infection, post-operative hematoma was less prevalent than what was reported in the literature.^{18,24} Hematoma resulted only in one out of

the 88 surgeries, which were treated conservatively and re-exploration was not required.

The main limitation of our study is that serum calcium level was followed up to 3 months post-operatively in the ENT clinics. The patients who experienced hypocalcemia on the third month were labeled as permanent hypocalcemic, and were referred to the Endocrine clinic for further management. So, the serum calcium status at 6 months or one year was not included in this study. The possibility remains that some of them have recovered from hypocalcemia in a later period and were weaned of treatment successfully. Another major limitation is that the measurement of PTH level was not included as one of our variables.

In conclusion, the combined effort of neuromonitoring and surgical loupes to identify and preserve RLN minimizes the rate of RLN injury. Using surgical loupes to identify the parathyroid glands helps to avoid unexpected injuries to the parathyroid gland. Using both of these apparatus in thyroidectomy results in a cumulative effect of reduced post-surgical complications and decrease hospital stay. Further studies are needed to assess the post-operative RLN function by high-speed laryngeal imaging, whether to confirm our strong low incidence of its injury, or to uncover a hidden asymptomatic injury. Conducting new studies with extended time of follow up to one year and measurement of PTH levels included might explain better the role of surgical loupes in preserving the parathyroid gland, thus reinforcing the justification of using surgical loupes in thyroidectomy as a standard of care.

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